

APPENDIX D

Factors for Decline

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1.0 Introduction

The decline of Pacific salmonids was caused by many factors. Among them are habitat loss and degradation, the effects of water development projects (e.g., hydropower dams, power plants, and diversions), changes in stream flow patterns and amount, predation by and competition with hatchery fish (as well as genetic effects), fish harvest; disease and predation, and inadequate regulatory mechanisms. These factors for decline are described here in a general way so that they may serve as a basis for the discussion of ESU-specific factors found in subsequent sections. Aspects of each factor for decline apply to all salmonids. It is important to note that the factors for decline are often inextricably linked and, together, can affect salmonids in ways that make it difficult to isolate any one factor as the cause of population decline. Nonetheless, the ESU-specific discussions identify the primary factors for decline where it is possible to do so.

2.0 Habitat Conditions and Impacts of Land Use Activities

Habitat degradation and loss together constitute one of the major causes of salmonid declines in the West. Salmonid habitat is currently protected under the legal descriptions “Essential Fish Habitat” and “Critical Habitat.” Essential Fish Habitat is defined in the Magnuson-Stevens Fishery Conservation and Management Act as waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Essential Fish Habitat for Pacific salmon includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Idaho, Oregon, and California, except above impassable barriers (NMFS 2000a).

Critical habitat for salmon is designated pursuant to the ESA and constitutes the geographic area considered to be essential for species conservation (February 16, 2000, 65 FR 7764). Critical habitat for the ESUs discussed here includes marine and freshwater areas as well as adjacent riparian zones, but excludes offshore marine areas that are under the jurisdiction of the Pacific Fishery Management Council (NMFS 2000b). Tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for at least several hundred years) are also excluded from the critical habitat designation.

The following discussion of the essential functions of freshwater, estuarine, and marine habitat is intended to give more background on the connection between habitat degradation and loss and declines in salmonid populations.

2.1 Freshwater Habitat

The condition of freshwater habitat is a critically important factor in the salmonid life cycle (Oregon Wetlands Joint Venture 1999a, Federal Caucus 2000). Riparian (riverside) vegetation

performs a number of ecosystem functions that affect water quality (Cederholm et al. 2000; U.S. Fish and Wildlife Service 1999; National Research Council 1996). Shade provided by vegetation regulates stream temperatures, which has a direct effect on salmonid physiology (subsection 4.8.3, Water Temperature) and also affects food supplies because it is a primary source of nutrients for the insects the fish prey on (Cederholm et al. 2000). Vegetation reduces sedimentation (subsection 4.8, Water Quality) by stabilizing stream banks and filtering runoff (U.S. Fish and Wildlife Service 1999; Natural Research Council 1996). Vegetation also provides a source of nutrients in the form of litter and through nitrogen fixation by some species, for example red alder (*Alnus rubra*) (Cederholm et al. 2000; U. S. Fish and Wildlife Service 1999). It is the source of the large woody debris that shelters fish, slows water flows, and helps increase and maintain stream complexity, factor favored by all salmonid species (Cederholm et al. 2000; U. S. Fish and Wildlife Service 1999). Large woody debris can also help to retain salmon carcasses, which are consumed by a number of species (Cederholm et al. 2000; U. S. Fish and Wildlife Service 1999). The retention of salmon carcasses benefit salmonids directly and indirectly. Juvenile salmonids feed directly on carcasses and salmonid eggs (Cederholm et al. 2000). Salmonids also feed on aquatic insects, which may experience population increases due to the food sources and nutrients supplied by carcasses (Gresch et al. 2000). Thus salmonids need healthy, well-distributed streamside vegetation of varying age. In addition, riparian areas are used at least seasonally by a large proportion of wildlife, including mammals, birds, and reptiles (Cederholm et al. 2000).

For instream habitat, salmon and steelhead require cold, clear water; a sufficient quantity of water; clean gravel for spawning; refuges from predators and fast flows; and food such as insects, salmonid carcasses, and eggs. All of which can be, and often are, affected by human activities.

2.2 Estuarine Habitat

Estuarine habitat is found at the interface between salt water and fresh water; salmonids use it when they undergo smoltification. Estuaries contain diverse assemblages of plant and animal species that serve as an important food source for salmonids and provide cover from predators (Pacific Fishery Management Council 1999).

The length of time that salmonids reside in estuaries varies. Chinook spend several months in estuaries before beginning ocean migration (Oregon Wetlands Joint Venture 1999a). Chum salmon generally spend more time in estuaries than other salmonids, and this period of residence seems to be an important factor in determining the future population size (Johnson et al. 1997). Nearly half of all Americans live near estuaries (Oregon Wetlands Joint Venture 1999a), and the resulting urbanization causes pollution that may adversely affect salmonids. Studies in several West Coast urban estuaries indicate that chinook salmon can accumulate high levels of pollutants during their relatively short residence time (Casillas et al. 1997). Wetlands account for

5.5 percent of the total land area of the United States. Estuaries, a type of wetland, account for 5 percent of wetland area (Dahl 2000). Because they are limited in distribution and provide important ecosystem services, damage to estuarine environments is of particular concern.

2.3 Marine Habitat

Salmonids spend 40 to 75 percent of their lives in marine areas (Oregon State University Extension Service 1998) where they prey on a variety of ocean fish and crustaceans. Populations of marine organisms vary with nutrient levels that are affected by global weather phenomena such as El Nino and changes in cold water upwelling along the western continental margins of the Americas (Cederholm et al. 2000). Because marine organism productivity levels affect salmon populations, ocean conditions play an important role in salmon population dynamics. Strong upwelling provides more nutrient-rich water and thus helps increase salmon populations; in El Nino years, upwelling is weakened, nutrient levels drop, and salmonid populations tend to decrease as well.

2.4 Impacts of Land Use Activities

Forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented marine, estuarine, and freshwater habitats. The net result of these activities is that increasingly greater portion of these habitats have become unsuitable for salmonid use (NMFS 1998a; Spence et al. 1996). Impacts associated with land use activities include changes in streambank and channel morphology, increased ambient water temperatures, destruction of spawning and rearing habitat, great reductions in downstream recruitment of spawning gravels and large woody debris, increased sedimentation, and removal of riparian vegetation (NMFS 1996). All of these factors have negative impacts on fish populations. For example, increased sedimentation alone is recognized as a primary cause of habitat degradation in the range of West Coast steelhead (NMFS 1998a).

Studies indicate that in most western states, about 80 to 90 percent of the historic riparian habitat has been eliminated (NMFS 1998a). In Idaho, 7,994 miles of streamside vegetation and 228,277 acres of lakeside vegetation were determined to be impaired (Bonneville Power Administration 2001a). Approximately 95 percent of riparian areas in freshwater habitat surveyed in Oregon in 1988 exhibited moderate or severe degradation. Similarly, 90 percent of the riparian forest and riparian wetlands of the Sacramento Valley in California have been cleared, filled, or otherwise eliminated (San Francisco Estuary Project 2000).

Reductions of wetland area have been reported throughout the analysis area. Wetlands have been destroyed throughout Washington and Oregon. Between the 1780s and 1980s, Washington lost 31 percent and Oregon lost 38 percent of wetlands (Dahl and Johnson 1991; Dahl 1990).

1 Additionally, historic wetlands have been reduced by 70 percent the Puget Sound, 50 percent in
2 Willapa Bay, and 85 percent in Coos Bay (NMFS 1998a). In the Columbia River Basin, over 50
3 percent of historic estuarine marshes and spruce swamps have been converted to other uses
4 (BPA 2001a). The current average annual rate of wetland loss in Oregon is 546 acres per year
5 (Oregon Wetlands Joint Venture 1999b). Idaho and California lost more than half (56 and 91
6 percent, respectively) of their wetlands between 1780s and 1980s (Dahl and Johnson 1991).
7 Ninety percent of California's coastal wetlands have been diked, paved over, developed, or
8 otherwise destroyed, and only 5 percent of the state's coastal wetlands remain intact (California
9 Department of Fish and Game 2001). The San Francisco Bay/Sacramento-San Joaquin Delta
10 estuary is the largest estuary on the west coasts of the Americas, and approximately 7.5 million
11 individuals now live in the 12 counties surrounding the estuary. Land use practices in these
12 counties, such as hydraulic mining, diking, and filling of tidal marshes, has decreased the surface
13 area of San Francisco Bay by 37 percent, and more than one-half million acres of the estuary's
14 historic tidal wetlands have been converted to farms, salt ponds, and urban uses (San Francisco
15 Estuary Project 1992). Intertidal wetlands in the San Francisco Delta have been diked so
16 thoroughly that of the 400,000 acres that existed in 1850, only 8,000 remain, that is, they now
17 comprise only 2 percent of their original extent (San Francisco Estuary Project 2000).

18
19 Urbanization has led to degraded salmon and steelhead habitat through stream channelization,
20 floodplain drainage, riparian damage, alteration of hydrology and geomorphology, reduced water
21 infiltration, increased sedimentation, and degraded water quality (Spence et al. 1996; NMFS
22 1996; Booth 1991; Booth et al. 1997; Paul and Meyer 2001). Point and nonpoint source
23 pollution from urban development results in increased discharges of nutrients, metals, pesticides,
24 and other contaminants, which degrades receiving rivers, streams, and wetlands (subsection 4.8,
25 Water Quality).

26 27 28 **3.0 Changes in Water Flow** 29

30 This section addresses all water development, powerplant, and hydropower projects that alter
31 water flow in estuaries, streams, and rivers. Water diversions, dam placements, and river
32 channelization for agricultural use, flood control, domestic water sources, and hydropower
33 purposes (especially in the Columbia River and Sacramento-San Joaquin watersheds) have
34 altered the abundance, spawning and rearing distribution, and migration timing of all salmonids
35 that use those waterways (NMFS 1998a). Water storage, withdrawal, conveyance, and
36 diversions have greatly reduced or eliminated historically accessible habitat and destroyed the
37 connectivity between important habitat areas. Water conveyance structures (i.e., water canals)
38 remove essential water from rivers and streams that historically produced the bulk of
39 California's salmon runs. Leakage from these structures can alter existing habitat and the canals
40 themselves can transport fish between watersheds and facilitate the movement of non-native fish
41 from reservoirs behind dams into outlet streams (California Department of Fish and Game 2001).
42

Human activities have modified natural flow regimes throughout the range of all salmon and steelhead on the West Coast and thus increased water temperatures, changed fish community structures, and decreased flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and large woody debris transport. Moreover, freshwater discharges into marine and estuarine habitats from sewage treatment plants and power plant cooling water can dilute the salinity of the receiving environment, alter species diversity due to thermal effects, and increase turbidity, which can affect kelp bed production (California Department of Fish and Game 2001).

Physical features of dams and powerplants, such as turbines and sluiceways, have killed hundreds of millions of adult and juvenile salmon and steelhead. Powerplants that use seawater for cooling can cause impingement of marine organisms on intake screens and destruction of larval forms of marine organisms that are pulled inside the plant (California Department of Fish and Game 2001). Attempts to mitigate the adverse impacts of these structures have had only limited success.

4.0 Fish Harvest

West Coast salmon and steelhead are harvested in tribal, commercial, and recreational fisheries throughout the Pacific Northwest (Pacific Fisheries Management Council 2000; Alaska Department of Fish and Game 1997). Salmon and steelhead are also taken for artificial production, supplementation, and broodstock collection, as well as for research purposes.

Harvest of west coast salmon and steelhead occurs in a variety of areas and methods, from open skiff tribal fisheries within the particular ESU to large purse seine vessels targeting healthy stocks in mix-stock fisheries off the shore of Alaska. Historically, the lack of coordinated management across these jurisdictions, coupled with competitive economic pressures to increase catches or to sustain them in periods of low production, has resulted in harvests that were too high. Additionally, over-fishing in the early periods of European settlement led to the depletion of many stocks of salmon and steelhead prior to extensive habitat degradation (NMFS 1996a). Following extensive habitat degradation, exploitation rates for many ESUs remained higher than was sustainable by natural production. In its listing decisions, NMFS concluded that harvest, along with other factors, was a factor of decline for many of the 14 salmon and steelhead ESUs. (65 FR 42422; NMFS 1996).

Current salmon and steelhead harvests have been substantially reduced from historical levels. Commercial sale of west coast salmon and steelhead harvest has been as high as 2.1 million fish in 1941 to a low of 68,000 fish in 1995 (The Federal Caucus 2000). Additionally, the 14 ESUs addressed in this EA are not all equally impacted by harvest. In particular, Lake Ozette sockeye salmon and Columbia River spring chinook and chum salmon are rarely caught in ocean fisheries. Where fisheries affect listed stocks, NMFS through its authority under the ESA, has

imposed additional restrictions to protect those stocks. The restrictions, along with the dramatic decline of productivity, have further reduced harvest opportunities on healthy as well as listed salmon stocks.

5.0 Hatcheries

Hatcheries are very important to the Pacific Coast recreational and commercial fishing economy. Millions of artificially propagated fish are released annually into rivers and streams flowing into the Pacific Ocean. Artificial propagation provides the majority of the fish harvested in the inland and near ocean recreational and commercial fisheries. Artificially propagated salmonids are also important in meeting tribal treaty harvest obligations. Federal court rulings have affirmed tribal treaty harvest rights and established the tribes as co-managers of the fisheries resource.

The history, development, and management of anadromous fish artificial propagation facilities in the Columbia River Basin has been summarized by the Columbia Basin Fish and Wildlife Authority and U.S. Fish and Wildlife Service (CBFWA 1990). Hatcheries were built and artificial propagation programs were funded to mitigate for declines in fish runs due to habitat destruction from hydropower construction, human development, resource extraction and overfishing. These programs were designed to provide fish for harvest and were generally successful; however, artificial propagation programs were identified as one of the factors responsible for the decline of naturally spawning salmonid populations. The use of artificial propagation carries with it inherent risks to indigenous fish populations. The development of extensive artificial propagation programs for anadromous fish, the increasing dependence on artificial propagation to support fisheries and compensate for habitat destruction, and the potentially adverse effects of these programs on native, naturally producing anadromous fish, has been well documented.

In general, the potential effects of artificial propagation on naturally produced populations include effects on the genetic and ecological health of natural populations, effects of fisheries management, and the potential to mask the status of naturally producing stocks which affects public policy and decision making. All these factors have contributed to the decline in naturally produced salmonids and has lead to the listing of many of salmon and steelhead stocks under the ESA. To address these listings and the decline in natural populations, there has been a shift in hatchery management from augmenting harvest to restoring, maintaining and conserving natural populations (RASP 1992; NPCC 1994; Fast and Craig 1997; Flagg and Nash 1999).

Under this shift in hatchery management, artificial propagation programs can be divided into two general groups: conservation programs and harvest augmentation programs. The goals of conservation programs are to restore and maintain natural populations. Conservation programs or supplementation programs (defined as the use of hatchery fish to increase natural production in the wild) can provide benefits to listed populations by:

- 1 • Using the hatchery to reduce the risk that a population on the verge of extirpation will be
- 2 lost by expeditiously boosting the number of emigrating juveniles in a given brood year.
- 3 • Preserving or increasing the abundance of salmonid populations while other factors
- 4 causing decreased abundances are addressed.
- 5 • Accelerating the recovery of populations by increasing abundances in a shorter time
- 6 frame than may be achievable through natural production.
- 7 • Increasing the “nutrient capital” in the freshwater ecosystem supporting natural salmonid
- 8 populations by increasing the numbers of decomposing supplementation program-origin
- 9 salmonid carcasses in a watershed.
- 10 • Establishing a reserve population for use if the natural population suffers a catastrophic
- 11 loss.
- 12 • Reseeding vacant habitat by reintroducing populations to streams where indigenous
- 13 populations have been extirpated while the causes of extirpation are being addressed.
- 14 • Using hatchery programs to collect and provide new scientific information regarding the
- 15 use of supplementation in conserving natural populations.
- 16

17 Harvest augmentation programs are designed to produce fish for harvest in commercial, tribal,

18 and recreational fisheries while having a neutral effect on the natural spawning populations.

19 These artificial production programs are also used to meet international harvest objectives set

20 forth under the Pacific Salmon Treaty agreement, and to mitigate for natural salmonid

21 production losses due to habitat blockage and degradation.

22

23 The current hatchery system in the Columbia River Basin includes over 70 hatchery programs

24 and associated satellite facilities, some of which were initiated more than 110 years ago, and

25 well before the salmon and steelhead were listed pursuant to the ESA. Hatcheries in the Pacific

26 Northwest have been used to mitigate for declines in salmon and steelhead abundance. Today,

27 most salmon populations in this region are primarily hatchery fish. In 1987, for example, 95% of

28 the coho, 70% of the spring chinook, 80% of the summer chinook, 50% of the fall chinook, and

29 70% of the steelhead returning to the Columbia Basin originated in hatcheries (CBFWA 1990).

30

31 The shift in hatchery management has led to artificial propagation hatchery reforms that may

32 require substantial and costly changes in existing programs and facilities, beginning with a

33 rigorous review of their goals and objectives. Because there is a range of scientific and policy

34 opinions regarding the purpose and appropriate application of artificial propagation in specific

35 circumstances, the application of a variety of strategies in different areas or under differing

36 conditions, coupled with an adaptive management approach, is warranted. As part of the

37 adaptive management approach, research and monitoring and evaluation activities will be

38 necessary to determine if the artificial propagation programs are achieving the management

39 goals for the program as well as minimizing adverse impacts to natural salmon and steelhead

40 populations.

41

42 The studies and reviews of artificial propagation in the Columbia River basin have identified a

number of major hatchery-specific reforms that include:

- Development of new, local broodstocks (eliminating inappropriate broodstocks).
- Construction of acclimation facilities for existing propagation programs.
- Construction of broodstock collection facilities or modifications to current facilities.
- Marking of all hatchery fish with appropriate internal and/or external marks.
- Development of Hatchery and Genetic Management Plans (HGMPs) with prescribed protocols.
- Reducing the numbers and locations of hatchery fish releases.

The California Department of Fish and Game (CDFG) and NMFS conducted a joint review of California's anadromous fish hatcheries between September 1999 and December 2000. This action was prompted by the listing of California salmon and steelhead populations under the federal ESA and the need to identify and evaluate the effects of hatchery operations on listed species. The primary goals of the review were to: (1) identify and discuss programs, policies and practices that are likely to arise as important issues in permitting hatchery programs under the ESA; (2) identify opportunities to use hatcheries to help recover listed salmon and steelhead populations; and (3) discuss emerging views on the operation and management of hatcheries for the purpose of recovering depressed natural stocks. In addition, sub-committees were formed to explore the topic of off-site releases and straying; and hatchery issues relating to the Klamath-Trinity Basin. The Joint Hatchery Review Committee produced a final report containing recommendations specific to individual hatcheries. The sub-committees developed recommendations on hatchery fish release strategies, and on hatchery management relating to Klamath-Trinity Basin salmonid stocks, in two appendix reports.

The rate of implementation of hatchery program reforms are dependent upon a number of factors. These factors include the availability of immediate funds, available broodstock, or the reform requires major hatchery facilities modifications. Some reforms can be implemented quickly including changing the number of hatchery fish released, altering the location of release to minimize ecological impacts to listed populations and preventing the transfer of inappropriate stocks to minimize genetic effects.

6.0 Disease and Predation

Infectious diseases affect adult and juvenile salmon and steelhead survival. Fish are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Numerous diseases have been documented to affect steelhead and salmon (NMFS 1998a, NMFS 1998b).

Introduction of non-native species and habitat modifications have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation experienced by

1 salmonids. Predation by marine mammals is also of concern in some areas experiencing
2 dwindling salmonid run sizes (NMFS 1998a).
3
4

5 **7.0. Inadequacy of Existing Regulatory Mechanisms**

6

7 Many of NMFS' status reviews and listing determinations for salmon and steelhead have
8 identified the inadequacy of existing regulations as one of the factors for decline affecting the
9 species. It is extremely difficult to quantify and analyze the extent to which existing regulatory
10 mechanisms have failed to protect different species, but the current poor health and low
11 abundance of many salmon and steelhead populations point to the fact that many existing
12 regulatory mechanisms have largely failed to prevent this depletion (NMFS 1998a).

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